Future Moon Mission Opportunities

Presentation at the
Lunar Science Conference

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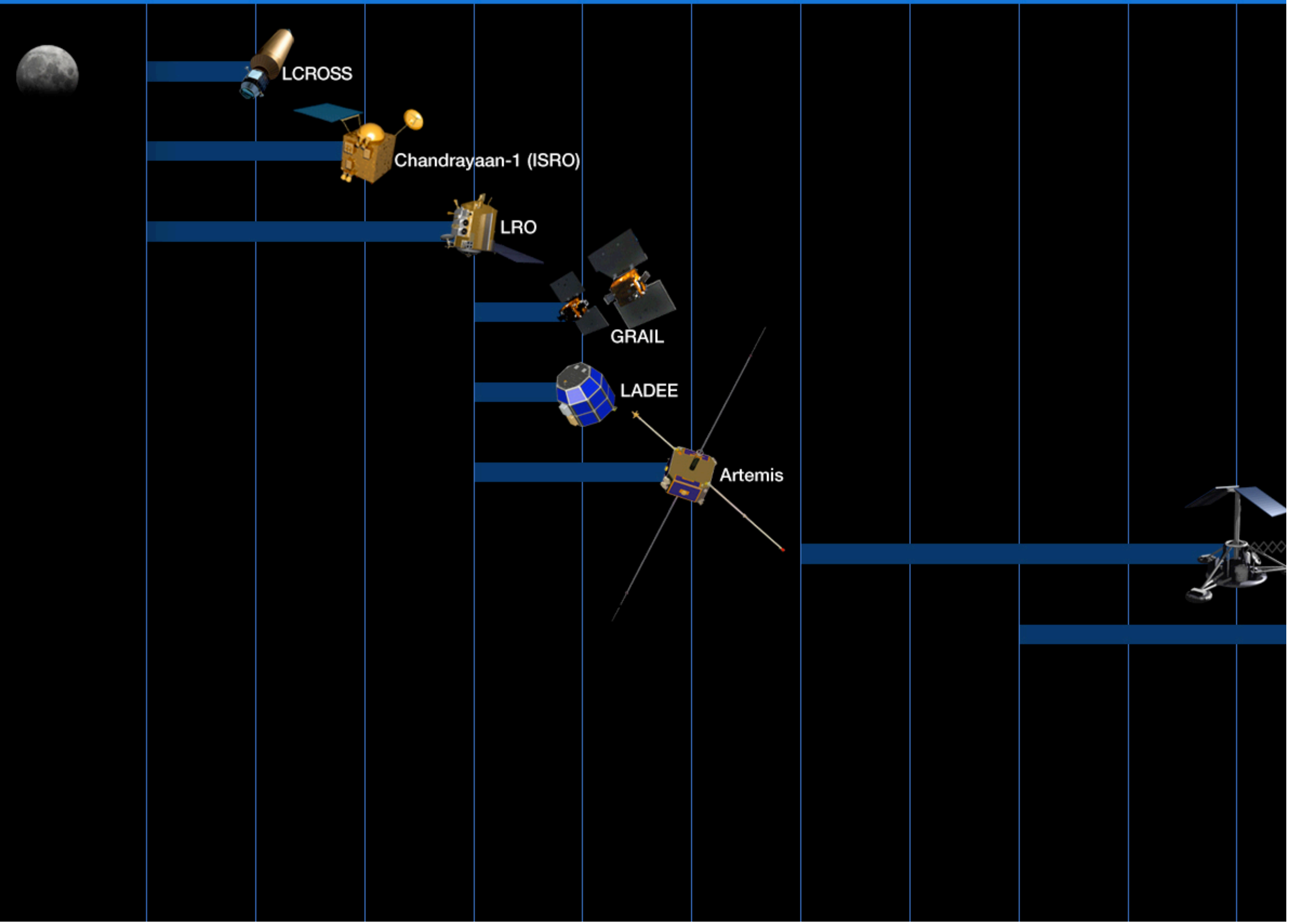
Director, Planetary Science Division

nar Mission timeline



Lunar Exploration Missions

Lunar Reconnaissance Orbiter (LRO)

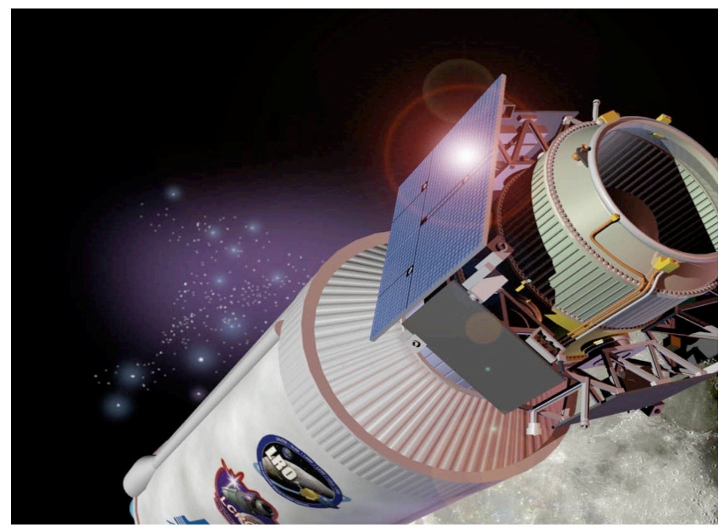
- Lunar mapping, topography, radiation characterization, and volatile identification
- 50km polar orbit
- One year operations
- ESMD Mission

Lunar CRater Observation and Sensing Satellite (LCROSS)

- Investigate the presence of water at the South Pole via a kinetic impactor and shepherding spacecraft
- ESMD Mission

LRO Prime Science Mission

- PSD funds LRO extended mission



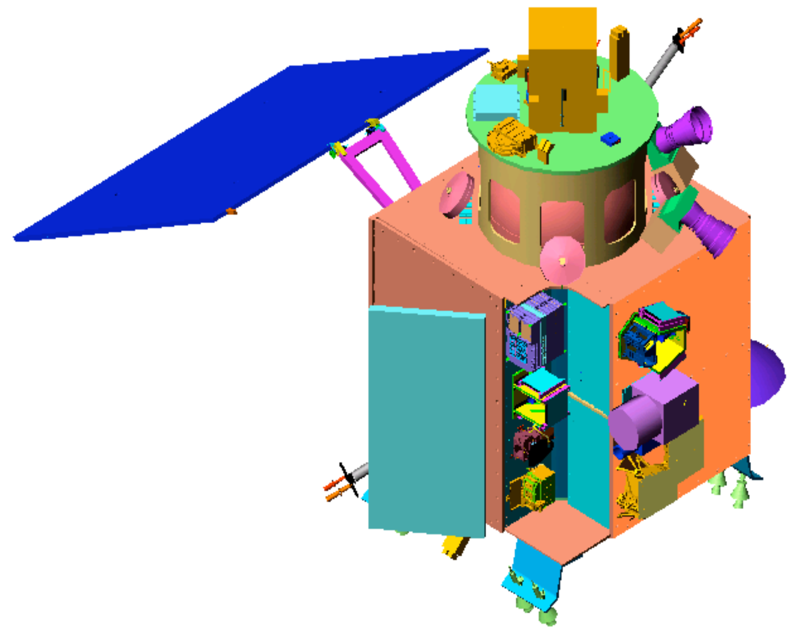
Moon Mineralogy Mapper (M^3)

<u>Team</u>

- PI: Dr. Carle Pieters, Brown University

<u>Mission</u>

- M3 Instrument on Chandrayaan-1, India's first deep space mission.
- One of 11 instruments (5 of which are non-ISRO, 2 of which are from the US)
- Launch Date: Sept-Oct 2008 on ISRO's Polar Satellite LV
- Lunar Orbit: 100 km, polar
- Operational life: 2 years

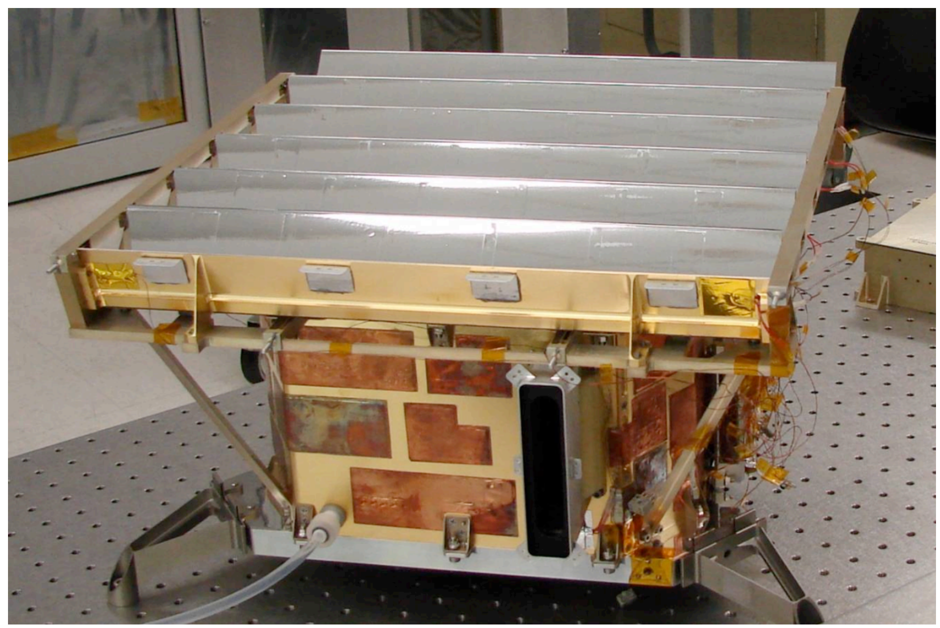


<u>Objectives</u>

- Produce a Global Map of the Mineralogy content Lunar surface at 140 m and 40 nm spectral resolution.
- Investigate specific targets at high spatial and spectral resolution
- Investigate the possibility of surface water ice at the lunar poles

<u>Instrument</u>

- A grating spectrometer, operating over the spectral region of 0.43 to 3 microns (Visible/Near IR)

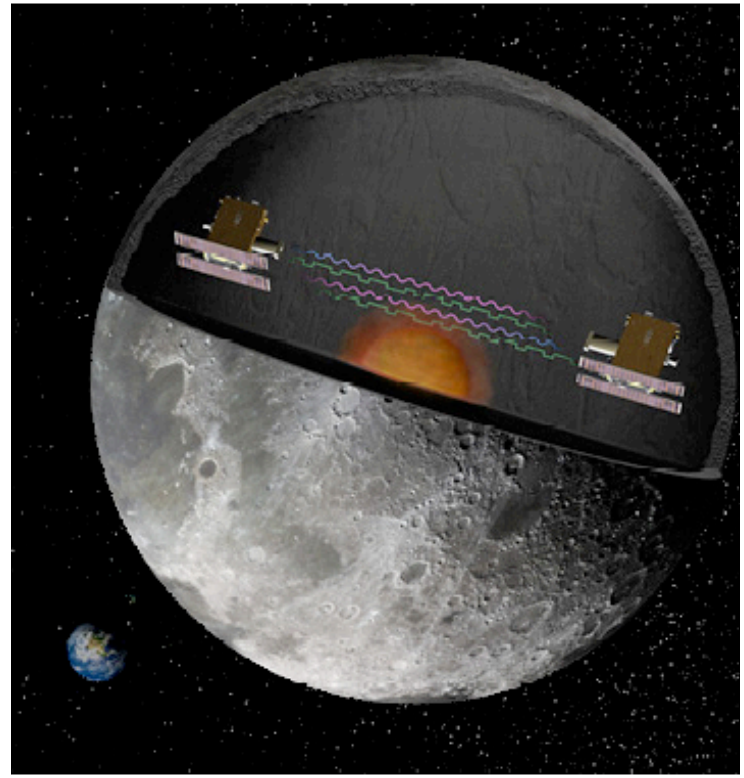


GRAIL: Gravity and Interior Laboratory

eam: PI Maria T. Zuber (MIT), DPI
vid E. Smith (GSFC), PM David H.
nman (JPL), PS Michael Watkins
PL), Co-I's from JPL, GSFC, UA,
ashington University, CIW/DTM, IPGP.

oals: Determine the structure of the
ar interior from crust to core; advance
derstanding of the thermal evolution of
Moon; extend knowledge gained from
Moon to the other terrestrial planets.

lission: Provide a global, high-
curacy (<10mGal),high-resolution
)km) lunar gravity map; build upon
ccessful GRACE mission; adapt flight-
oven LM XSS-11 bus to the duel
acecraft design.



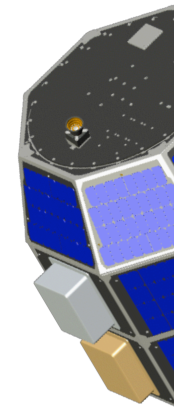
• **Instrument:** Ka-band ranging
determines the precise instanta
relative range-rate of the two s/
instrument is based on GRACE

• **Flight:** 3–4 month low energy
lunar cruise; LOI maneuvers s

Lunar Atmos. & Dust Environment Expl

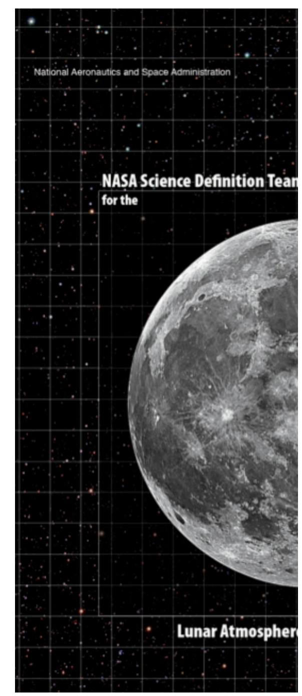
LADEE examining the lunar atmosphere/exosphere

- Science Definition Team Report released May 23, 2008
- Chair: Laurie Leshin, GSFC



Science:

- Objective 1: Determine the composition of the lunar atmosphere and investigate the processes that control its distribution and variability, including sources, sinks, and surface interactions
- Objective 2: Characterize the lunar exospheric dust environment and measure any spatial and temporal variability and impacts on the lunar atmosphere

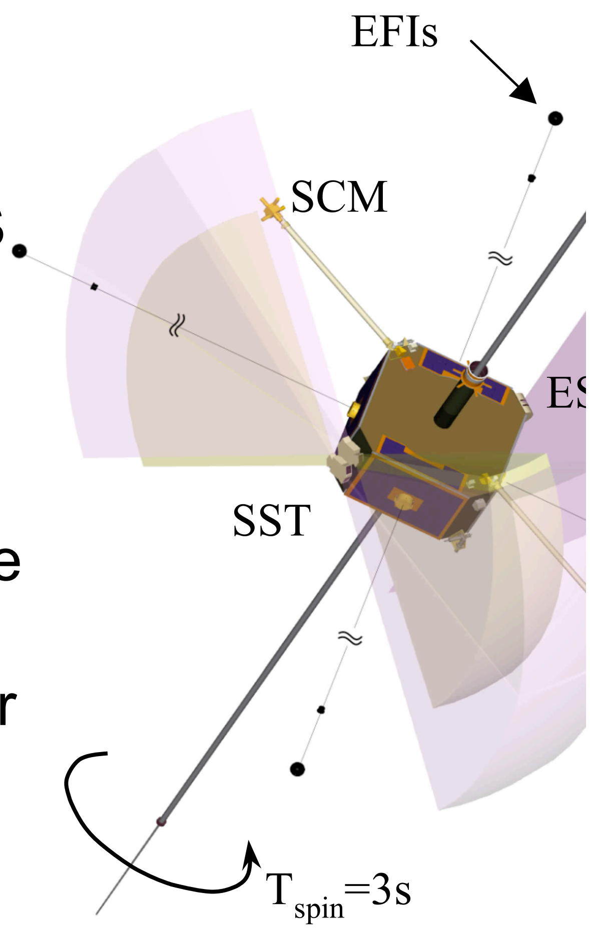


Instruments:

- Neutral mass spectrometer - Paul Mahaffy/GSFC
- Ultraviolet/visible spectrometer - Tony Colaprete/ARC
- Dust Detector - to solicited in SALMON
- Demo: Laser communications

Themis Mission Extension to the Moon: Art

- Heliophysics mission to study plasma wake effects - 2 of the 5 s/c
- Complements LADEE observations
- Lunar Surface:
  – Study composition and distribution of sputtered ions
  – Understand crustal magnetic fields, surface charging
  – Remotely sense surface properties of lunar regolith
- Lunar Exosphere:
  – Study composition, distribution of exospheric ions under a variety of solar wind and magnetospheric conditions



<u>Probe instruments:</u>
ESA: ElectroStatic Analyze
(cols: *Carlson and McFadd*
SST: Solid State Telescope
FGM: FluxGate Magnetom

ILN Missions

- International Lunar Network (ILN) missions
  - First two ILN anchor nodes 2013-2014
  - A second pair of ILN nodes in 2016-2017
  - Investigating use of Radio Isotope Power
- ILN is designed to emplace 6-8 stations on the lunar surface - fixed or mobile
- NASA is studying the option for a lunar comm relay orbiter for lunar far-side nodes

- Each ILN station:
  - Has a core set of instrument types (e.g., seismic, laser retro-reflector, heat flow) requiring broad geographical distribution
  - Could also include additional instruments as desired by the sponsoring space agency
  - Could also include additional passive, active, ISRU, or engineering experiments, as desired by each sponsoring space agency

New Frontiers Program

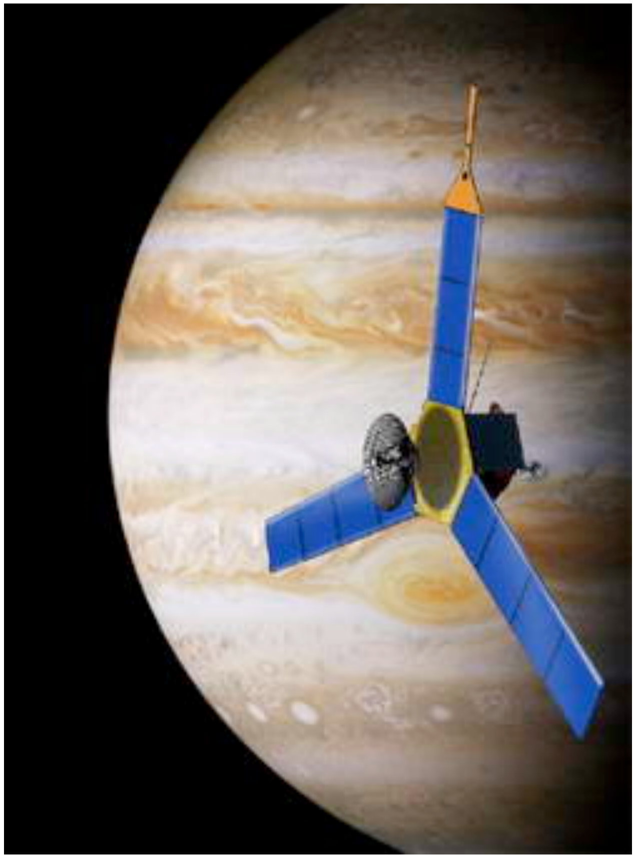
1st NF mission
New Horizons:

Pluto-Kuiper Belt Mission

nched January 2006

2nd NF mission
JUNO:

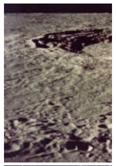
Jupiter Polar Orbiter Mission



August 2011 launch

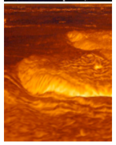
3rd NF mission oppo

South Pole Aitken Basin Sample Return

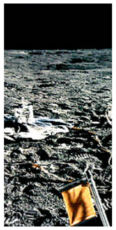


Comet Surface Sample Return (CSSR)

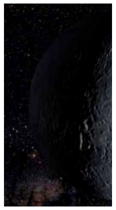
Venus In Situ Explorer (VISE)



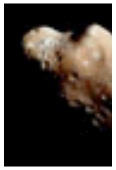
Network Science



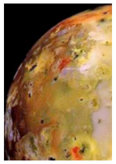
Trojan/Centaur



Asteroid Sample Return



Io Observer



Supporting Research Activities

Lunar Supporting Research & Techn

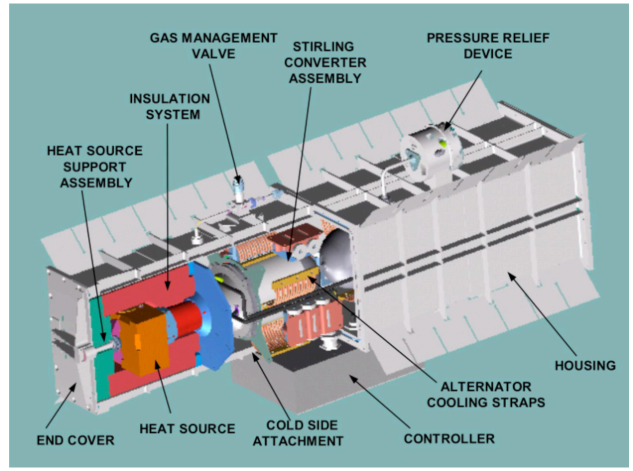
- LRO Participating Scientist Program
  - Selection completed on March 5, 2008
- Lunar Advanced Science & Exploration Research program (LASER)
  - Basic & Applied lunar research
  - Selection completed in May 2008
- Moon & Mars Analog Mission Activities Program (MMAMA)
  - Designed to enhance science integration into the Explor architecture & technology development process
  - Selection completed on May 18, 2008
- NASA Lunar Science Institute Cooperative Agree Notice for nodes

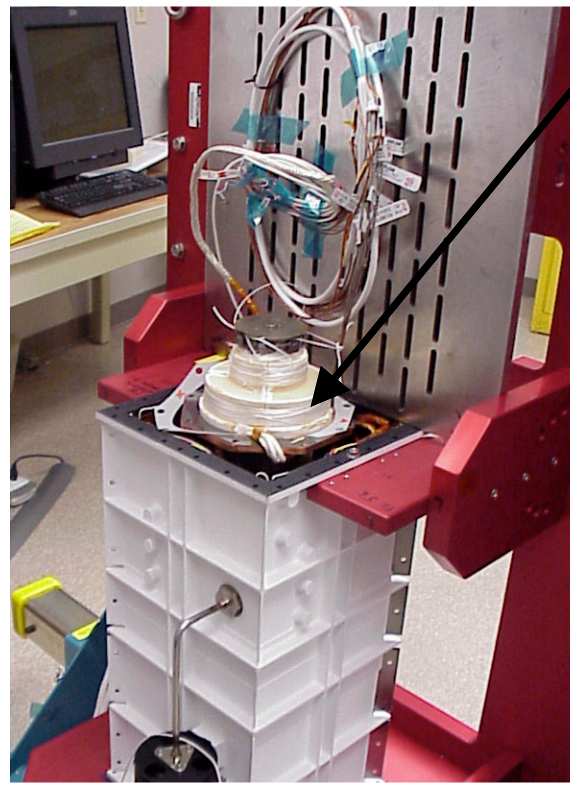
Technology and Instrumentation

- Lunar Sortie Science Opportunities (LSSO)
  - One-year concept studies
  - Selected 14 studies last year
  - Spans geology, geophysics, physics, astronomy, & astrophysics
- Planetary Instrument Definition & Development Program (PIDDP)
  - Several lunar-focused instruments selected in 2007
  - Augmented in 2008 for add'l lunar instrument development
- Stand-Alone Mission of Opportunity Notification (SALMON)
  - Call for instruments will include Lunar dust instrument on LAD
  - To be released in August 2008
- Discovery and Mars Scout Mission Concept Stud
  - New concepts using a GFE - Radioisotope Power System
  - Received 41 proposals

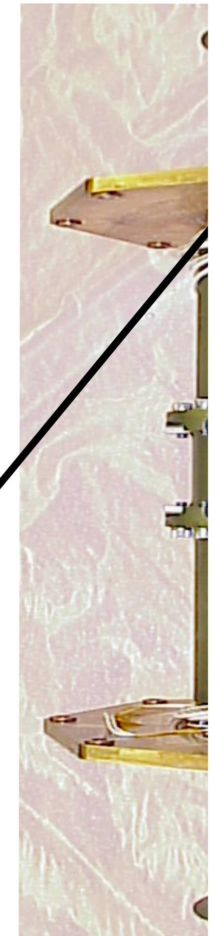
Advanced Stirling Radioisotope Generator Engineering Unit

- Operation in space and on surface of atmosphere-bearing planets and moons
- Characteristics:
  - ≥14 year lifetime
  - Nominal power : 140 We
  - Mass ~ 20 kg
  - System efficiency: ~ 30 %
  - 2 GPHS (“Pu^{238} Bricks”) modules
  - Uses 0.8 kg Pu^{238}
- Engineering Model and Test Program successfully completed in June 2008.





Lockheed



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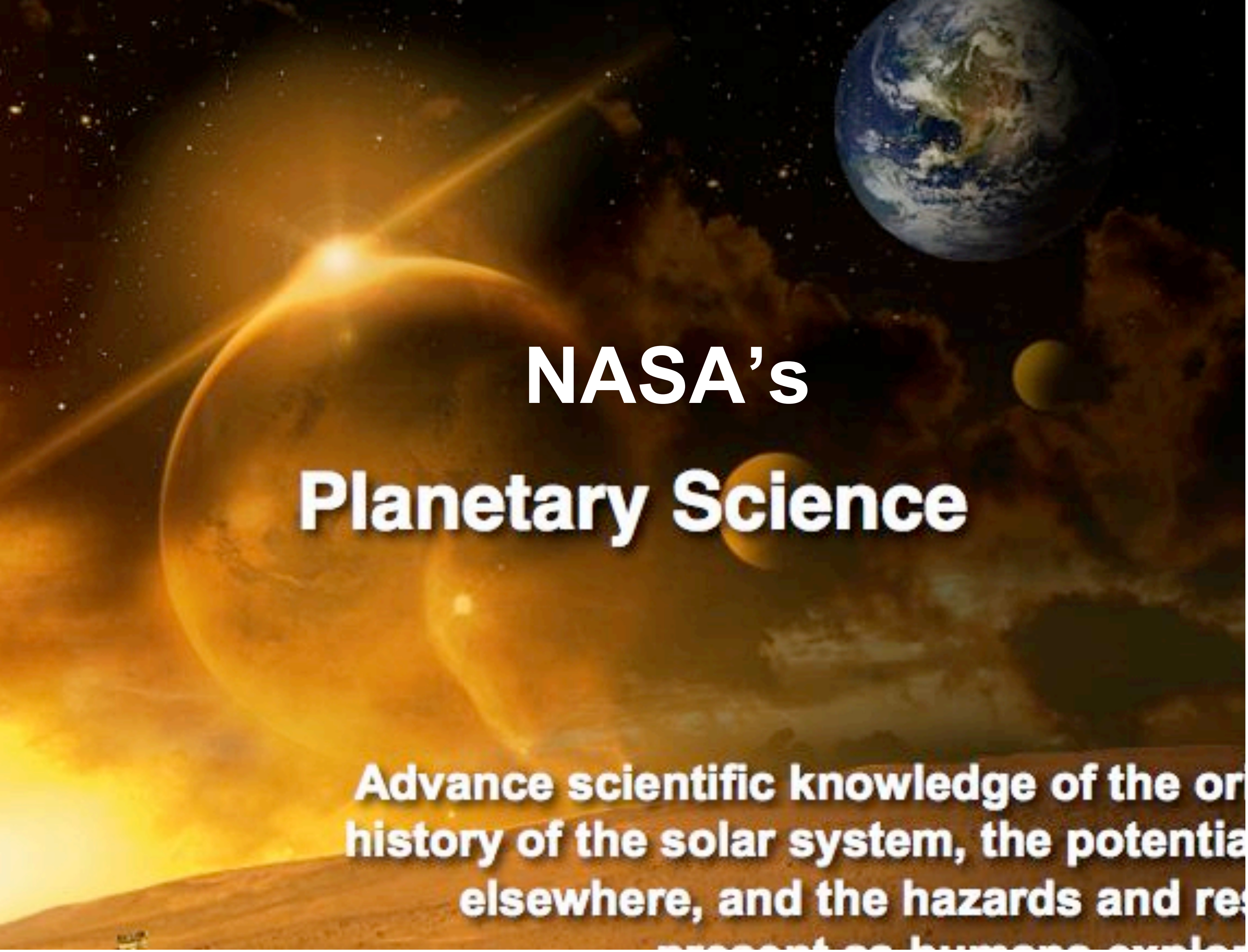
Discovery and Mars Scout Missio
Concept Studies - Selections

aines, Kevin	JPL	Venus	Aerial Vehicle	Polar VALOR: The Feasibility of A Nuclear-Po Duration Balloon Mission to Explore the Poles
phic, Richard	Los Alamos National Laboratory	Moon	Lander	Locating and Characterizing Lunar Polar Vola of a Discovery-Class Mission
lliff, Bradley	Washington University	Moon	Rover	Journey to the land of Eternal Darkness and Ic Lunar Polar Volatile Explorer
vkin, Andrew	Applied Physics Lab	Asteroid	Lander	Ilion: An ASRG-Enabled Trojan Asteroid Missi
echt, Michael	JPL	Mars	Lander	A tour through Martian history: An ASRG-pow borehole.
ofan, Ellen	Proxemy Research	Outer Planets	Lander	Titan Mare Explorer (TiME)
cEwen, Alfred	University of Arizona	Outer Planets	Orbiter	Mission Concept: Io Volcano Observer (IVO)
andford, Scott	NASA/AMES	Comet	Sample Return	Concept Study for a Comet Coma Rendezvou Return Mission
unshine, Jessica	Univeristy of Maryland	Comet	Lander	Comet Hopper

NASA's


Planetary Science
Advance scientific knowledge of the or
history of the solar system, the potentia
elsewhere, and the hazards and re